Chip Design
SS 2008

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Exercise 7

1. Show that the Single Row Placement problem is *NP*-hard if the circuit order need not be maintained. (Hint: Recall Theorem 2.3) (6 points)

2. Show that the Undirected Edge-Disjoint Paths Problem remains *NP*-complete even if the grid graph G is a complete planar rectangular grid graph. (6 points)

3. Formulate the Simple Global Routing Problem as an integer linear program (ILP) with a polynomial number of variables and constraints. (6 points)

4. Given an instance of the Simple Global Routing Problem and additionally a list $\mathcal{P}$ of timing critical paths with delay bounds $D : \mathcal{P} \to \mathbb{R}_+$. Each path $P \in \mathcal{P}$ consists of a sequence $C_1, N_1, C_2, N_2, \ldots, C_{n_P-1}, N_{n_P-1}, C_{n_P}$ of circuits $C_i \in \mathcal{C}$ and nets $N_i \in \mathcal{N}$ in the netlist. Let $\mathcal{Y}_N$ be the set of Steiner trees for $N \in \mathcal{N}$. A delay function $d_N : \mathcal{Y}_N \to \mathbb{R}_+$ specifies the delay through driver circuit C to the source pin $p \in N$ ($\gamma(p) = C$). The delay depends linearly on the length of the Steiner tree $Y_N \in \mathcal{Y}_N$:

   $$d_N(Y_N) := a_C + b_C \cdot \sum_{e \in E(Y_N)} l(e)$$

   with constants $a_C, b_C > 0$ depending on the driving circuit C.

   The delay bounds are preserved if

   $$\sum_{N \in P \cap \mathcal{N}} d_N(Y_N) \leq D(P) \text{ for all } P \in \mathcal{P}.$$

   Show that the Simple Global Routing Problem with these additional delay constraints can be modeled as a Resource Sharing Problem. (6 points)

The deadline for problems is **Tuesday June 10 at 12:15**, before the lecture.